NASA Earth Science Division, Applied Sciences Program
Disasters

Summary of Calendar Year 2012

The Disasters Applications area promotes the use of Earth observations to improve forecasting, mitigating, and responding to natural and technological disasters. In 2012, the Disasters area portfolio had projects with regional to global reach in earthquakes, flooding, and other topics. The Disasters area also organized NASA's contributions to disaster response, such as wildfires in the United States, Typhoon Bopha in the Philippines, and flooding in Pakistan.

Major Project Accomplishments

In 2012, the Disasters area made significant progress, and past investments hit milestones toward increasing disaster preparedness and mitigation. One project working in the Sacramento-San Joaquin River Delta validated employing NASA's UAVSAR for rapidly detecting seeps or structural damage in levees. This novel use of radar remote sensing identifies subtle changes in levee conditions before catastrophic failure. Due to the value of this project to California water resources and emergency management, the state committed additional funding for UAVSAR flights until 2014. DHS and USACE also began exploring the application of the project's outcomes.

A project known as E-DECIDER continued integrating *Landsat*, MODIS, and other data into earthquake disaster forecasting, response, and recovery. The project team participated in a major California earthquake response exercise, integrating its decision support tools into state emergency management operations. The project also supported the implementation of DHS middleware for data sharing among emergency management organizations. The project's conclusion in 2013 will offer innovative evaluation and response resources to FEMA, USGS, and other federal, state, and local agencies.

Disaster Response Assistance

In addition to applications development, the Disasters Applications area led NASA's response to disasters that occurred in 2012. NASA supported the response to 18 events in 2012, making Earth observations and satellite imagery available to support emergency managers and disaster responders.

To support fire perimeter and other assessments, NASA provided MODIS, ASTER, and LANCE near real-time products to fire managers responding to events in High Park and Waldo Canyon, Colorado, as well as wildfires across California, Nevada, and New Mexico. In addition, NASA provided LANCE, MODIS, and *TRMM* data and imagery to assist damage assessment for and response to Tropical Storm Debby in the Gulf of Mexico, and Tropical Storm Isaac in the Caribbean. For flooding in Pakistan and Russia, NASA delivered LANCE and MODIS Rapid Response products in collaboration with the Dartmouth Flood Observatory.

For Hurricane Sandy, NASA provided observations in the hours, days, and weeks after the disaster. Based on data derived from *Suomi NPP*/VIIRS, NASA provided images to FEMA, USGS, and the U.S. Army to help monitor regions without power. Disaster responders used the images to support their efforts to distribute relief supplies and equipment. NASA also provided products based on *Terra*/ASTER data to assist in disaster assessment.

Roughly a month later, Typhon Bopha hit the Philippines. Using products from *TRMM*, *Terra* (ASTER, MODIS), *Aqua* (AIRS, MODIS), and *Suomi NPP*/VIIRS, NASA delivered products through the International Charter on Space and Major Disasters to support disaster mitigation, such as multi-satellite precipitation analysis and flood maps. Moreover, NASA used the techniques on power outage assessments developed for Hurricane Sandy to support NASA contributions to the Bopha disaster response.

New Projects

The Disasters area selected 17 new projects under an open, competitive solicitation focused on flooding, earthquakes, volcanic effluent, and landslides. Using Applied Sciences' new approach to solicitations, the 17 projects began in 2012 as short-term feasibility studies of potential applications. For example, one study is examining the use of MODIS and future sensors to aid flood inundation predictions for the U.N. World Food Program and its decisions on flood damage assessment, food assistance, and transportation access. The Disasters area will select a subset of successful, feasible ideas to pursue as multiyear, in-depth projects.

GEO/CEOS

The NASA Applied Sciences Program leads a component in a GEO Disasters task and sponsors disaster-related activities under CEOS. In 2012, activities included the ongoing development of flood alert pilots in the Caribbean and Namibia, the articulation of a structure for expanding disaster partnerships among space agencies, and the development of an overall observation strategy to support disaster mitigation. For a CEOS disaster risk management effort, the Program helped create three thematic pilots on floods (led by NASA), seismic hazards, and volcanoes. The NASA team helped author a CEOS floods gap analysis report, which is due for publication in 2013. Francis Lindsay, program manager for Disasters Applications, organizes NASA contributions to the task component.

The Disasters Applications area was actively involved with CEOS in 2012 to develop a plan for disaster risk and management. In December, NASA hosted a meeting of the CEOS Disasters team, which prepared initial materials for a 2013–2015 "road map." The team expects to present the road map at the CEOS SIT meeting in March 2013.

Other Community Involvement

In 2012, the Disasters area participated in a U.N.-hosted Experts Meeting on Crowdsource Mapping for Disaster Risk Management and Emergency Response. The meeting examined crowdsourcing approaches already in practice as well as the use of space-based data as inputs for disaster response, such as abilities to crowdsource disaster assessment based on satellite data. Francis Lindsay, Disasters Applications program manager, presented

information on E-DECIDER's efforts to use "citizen seismology" in the improvement of post-earthquake damage assessment maps.

Looking Ahead

In 2013, the Disasters area will select a subset of feasibility studies begun in 2012 to pursue as in-depth, multiyear applications projects. It will continue to support CEOS efforts for international coordination on disasters, and it will continue to lead NASA's support and response to disasters in the United States and abroad.

Summary of Projects: Calendar Year 2012

Project: Earthquake Data Enhanced Cyber-Infrastructure for Disaster Evaluation and Response (E-DECIDER)

Principal investigator: Margaret Glasscoe, NASA Jet Propulsion Laboratory

Project year: 4

Year-end ARL: 6

Description:
- Provide decision support for earthquake disaster management and response utilizing remote sensing data and modeling software.
- Deliver Web-based infrastructure including rapid and readily accessible satellite imagery and UAVSAR interferograms following earthquakes; standards-compliant map data products; and deformation modeling and earthquake forecasting results.
- Develop decision support tools in partnership with end users in first response and disaster management agencies, but primarily with project partner USGS.

Data sources, models, technology: Southern California Integrated GPS Network, MODIS, Plate Boundary Observatory, *Landsat*, UAVSAR, NASA's QuakeSim project

Major accomplishments in CY 2012:
- Published article in *Tectonophysics* (Yoder et al.) and two articles in *Computing in Science and Engineering* (Donnellan et al. and Wang et al.).
- Produced automated deformation results through RSS-disloc feed for March 20 Mexico and September 7 China earthquakes; published with associated tilt change maps on E-DECIDER website.
- Installed and deployed FEMA UICDS software for decision support data distribution.
- Participated in Golden Guardian response exercise (May); participated in Great California ShakeOut response exercise (October).
- Presented outcomes at the Great Japanese Earthquake & Tsunami: Lessons Learned for California One Year Later, Chapman University; AGU Fall Meeting; UJNR Meeting, etc.
- Conducted second end user workshop in November.

Plans or expectations for 2013:
- Integrate data product workflow into automated processes; refine map service delivery; continue collaborating with partners and end users in exercises and workshops.
- Deploy and integrate E-DECIDER system for end users in 2013 ShakeOut exercise.
- Complete project to benefit FEMA, USGS, California Geological Survey, California Emergency Management Agency, and other federal, state, and local agencies.

- Expected ending ARL: 8 (October 2013).

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Project: Extending AWIPS II Visualization and Collaboration Capabilities for Enhanced Decision Making using NASA Data within NOAA NWS and FEMA

Principal investigator: Dave Jones, StormCenter Communications, Inc.

Project year: 4

Year-end ARL: 9

Description:
- Establish the Envirocast Vision Collaboration Module (EVCM) software as a multi-platform Windows-based visualization and collaboration decision support tool within the NWS Southern Region Headquarters and FEMA Region VI.
- Capability to collaborate in real time now exists on Windows-based PCs, including laptops, tablets, desktops, and mobile devices with browser capability.
- End users: NOAA, FEMA, and other federal, state, and local agencies.

Data sources, models, technology: multiple, e.g., *TRMM* rainfall data, *GOES* data for storm positioning and movement, land cover data from *Terra* and *Aqua*, *EO-1* observations, USACE Inundation Depth Grid model, NOAA research models, etc.

Major accomplishments in CY 2012:
- FEMA Region VI officially requested that NWS Southern Region Headquarters use EVCM-G (federal government-wide version) for its weather briefings.
- NWS launched EVCM in its Operational Proving Ground (May) for possible rollout to the entire NWS.
- Presented technology/outcomes at conferences, workshops, and training sessions of NWS, OFCM, WMO, etc.
- Participated in *Soumi-NPP* Applied Sciences Workshop (June), to provide input on current and future usage for NASA data in collaboration sessions.

Plans or expectations for 2013:
- Implement EVCM-G within NWS SR and FEMA Region VI, possibly deploying EVCM on
- FEMA laptops.
- Introduce EVCM-G to FEMA HQ and additional FEMA Regions.
- Expand EVCM-G “trusted” data sources for operational decision making and briefings between NWS Southern Region Headquarter and FEMA Region VI.
- Document advances and product value to users.
- Expected ending ARL: 9 (July 2013).

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Project: Global Flood and Landslide Estimation

Principal investigator: Robert Adler, University of Maryland

Project year: 4

Year-end ARL: 6

Description:
- Provide global flood and landslide estimation techniques using satellite rainfall and hydrological models and algorithms.

Data sources, models, technology: *TRMM* data, Numerical Weather Prediction data

Major accomplishments in CY 2012:
- Tested, validated, and published flood detection algorithm based on hydrological model: real-time results available via *http://oas.gsfc.nasa.gov/globalflood*.
- Tested, validated, and published landslide algorithm: real-time results available via *http://trmm.gsfc.nasa.gov/publications_dir/potential_landslide.html*.
- Began transfer of real-time flood and landslide information for use by Pacific Disaster Center.
- Presented Australia example in real time at International Workshop on Global Flood Monitoring and Modeling in Delft, Netherlands (March), showing flood detection, stream-flow, and rainfall output.
- Submitted two articles (accepted) to *Journal of Hydrometeorology* (Wu et al. on global flood detection, and Kirschbaum et al. on impact of climate variations on landslides).
- Detected and monitored flooding in North Korea, West Africa, and Pakistan.

Plans or expectations for 2013:
- Increased stakeholder collaboration, integration, and use.
- Feasibility study (floods) will improve system for semi-operational prototype in NOAA institute for evaluation/use by national and international agencies (e.g., NOAA, ACE, International Red Cross, insurance companies) [ARL 7].
- Funding beyond feasibility study will allow for full implementation and advancement of flood technique to ARL 8 and 9.

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Project: MODIS Near Real Time Global Flood Mapping

Principal investigator: Fritz Policelli, NASA Goddard Space Flight Center

Project year: 3

Year-end ARL: 5

Description:
- TBD

Data sources, models, technology: MODIS

Major accomplishments in CY 2012:
- System now providing daily near real-time surface water and flood extent two-day composite products with global coverage.
- Achieved significant improvements in geolocation (LANCE partnership).
- Prototype service: *http://modis.geobliki.com*.

Plans or expectations for 2013:
- Expected ending ARL: 6 (September 2014).

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Project: Monitoring Levees and Subsidence in the Sacramento-San Joaquin Delta using UAVSAR

Principal investigator: Cathleen Jones, NASA Jet Propulsion Laboratory

Project year: 4

Year-end ARL: 4

Description:
- Assess monthly the condition of the levees in the Sacramento-San Joaquin Delta for changes in the levee conditions, using differential interferometry and UAVSAR data to monitor small changes in the levees' positions.
- Measure yearly subsidence rates throughout the islands of the delta.
- Use the information to quantify the impact of subsidence on levee stability, support state water resources management and emergency response, and to better understand subsidence mechanisms and rates in the Sacramento-San Joaquin Delta.
- Partners/end users: California Department of Water Resources, USGS.
- Potential end users: FEMA, USACE, USFS, DHS Science and Technology Directorate.

Data sources, models, technology: UAVSAR, space-based SAR

Major accomplishments in CY 2012:
- Developed method to identify seeps using short temporal baseline coherent change detection during tidal extremes.
- Used pair-wise DInSAR to identify a cracked levee and to track the extent and amount of change along the repaired section in the years following repair.

- Identified areas with long-term subsidence along the landside levee slope and toe berm on several islands.
- Developed advanced dynamic subsidence model for comparison with UAVSAR-derived velocity maps, to be used for long-term water resource management in the Sacramento-San Joaquin Delta.
- Developed time series stack DInSAR processing capability for UAVSAR.
- Developed low correlation DInSAR processing techniques of value for the *DESDynI-R* mission science applications and for its data processing algorithm development.
- Presented (talks, posters, papers) at conferences, workshops, and meetings with local, state, and federal agencies.
- Generated support for a related DHS study to develop methods to expand remote sensing of levees to satellite SAR-based observations for long-term, economic, levee and dam monitoring and emergency response on a national scale.

Plans or expectations for 2013:
- Focus on gathering additional time series data from UAVSAR flights, and processing of the current data archive for the purpose of deriving the levee stability products.
- Hold a joint workshop with stakeholders in the California Department of Water Resources and DHS.
- Expected ending ARL: 6.

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Project: Rapid Earthquake Products from Analysis and Imaging for Response (REPAIR)

Principal investigator: Susan Owen, NASA Jet Propulsion Laboratory

Project year: 1

Year-end ARL: 4

Description:
- Improve response and recovery to earthquake-related disasters by working with USGS to provide rapid fault models and refined damage maps that integrate GPS and InSAR into seismic earthquake response systems.

Data sources, models, technology: global GPS, InSAR

Major accomplishments in CY 2012:
- Presented/discussed this work at a meeting with USGS in December 2012.

Plans or expectations for 2013:
- Expected ending ARL: TBD (September 2013).

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Acronyms

AGU: American Geophysical Union
ARL: Applications Readiness Level
ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer
CEOS: Committee on Earth Observation Satellites
DESDynI-R: DESDynI-R: Deformation, Ecosystem Structure and Dynamics of Ice (Radar)
DHS: Department of Homeland Security
DInSAR: Differential Interferometric Synthetic Aperture Radar
E-DECIDER: Earthquake Data Enhanced Cyber-Infrastructure for Disaster Evaluation and Response
EVCM: Envirocast Vision Collaboration Module
FEMA: Federal Emergency Management Agency
GEO: Group on Earth Observations
GOES: Geostationary Operational Environmental Satellite
GPS: Global Positioning System
LANCE: Land Atmosphere Near real-time Capability for EOS
MODIS: Moderate Resolution Imaging Spectroradiometer
NASA: National Aeronautics and Space Administration
NOAA: National Oceanic and Atmospheric Administration
NPP: National Polar-orbiting Partnership
NWS: National Weather Service
OFCM: Office of the Federal Coordinator for Meteorology
ROSES: Research Opportunities in Space and Earth Sciences
SAR: Synthetic Aperture Radar
TRMM: Tropical Rainfall Measuring Mission
UAVSAR: Uninhabited Aerial Vehicle Synthetic Aperture Radar
UICDS: Unified Incident Command and Decision Support
UJNR: U.S.-Japan Cooperative Program in Natural Resources
USACE: United States Army Corps of Engineers
USFS: United States Forest Service
USGS: United States Geological Survey
WMO: World Meteorological Organization

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